Modulation of interoceptive processing by hypnotizability

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Introduction

Interoception, i.e., the ability to perceive and interpret internal bodily signals (*Craig, 2002*), is involved in different emotional and cognitive processes (*Critchley & Harrison, 2013*) and is therefore cruical for maintaining good mental and physical health (*Khalsa et al., 2018*).

Hypnotizability is a psychophysiological trait associated with several morpho-functional brain characteristics that may also be relevant to interoception. Imaging studies (*Landry et al., 2017; Picerni et al., 2019*) have shown lower insular gray matter volume in highly hypnotizable individuals (highs) compared to low hypnotizable individuals (lows), which may account for their lower interoceptive accuracy (IA) and lower hearbeat-evoked cortical potentials (HEP) reported in previous studies (*Callara et al., 2023*; *Rosati et al., 2021*).

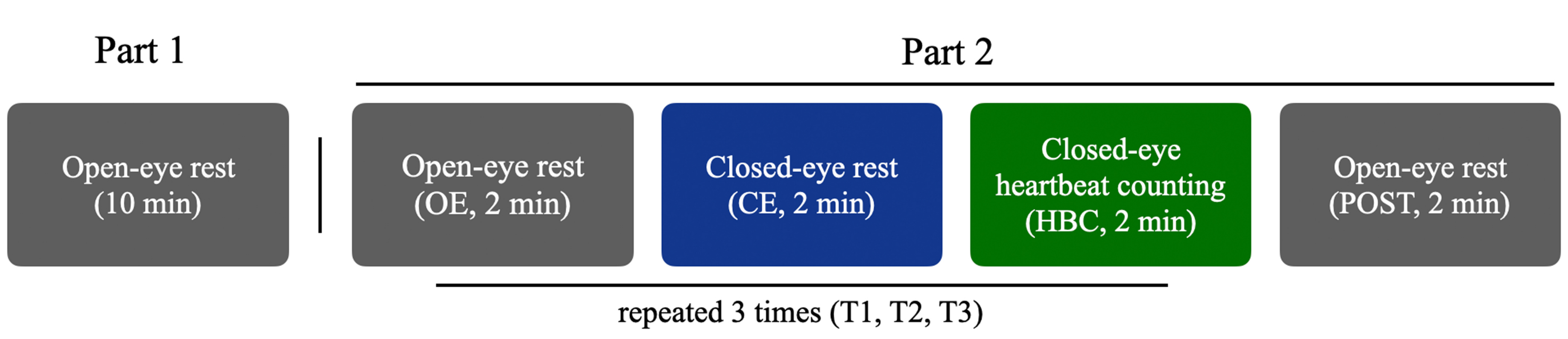
As medium hypnotizable individuals (mediums), who represent 70 % of the general population (*De Pascalis et al., 2000*), were not included in the previous HEP study, we aimed to examine interoceptive processing in all three hypnotizability groups. In addition, we aimed to investigate the role of attention paid to the heartbeats on interoception in the different hypnotizability groups.

Method

Participants

Forty-six healthy students (age: M = 24.46, SD = 3.66), classified into groups of lows (18; 12 females), mediums (14; 6 females) and highs (14; 8 females) according to Stanford Hypnotic Susceptibility Scale: Form A (SHSS: A; *Weitzenhoffer & Hilgard, 1959*; range: 0 - 12; 0 - 4: lows; 5 - 7: mediums; 8 - 12: highs).

Experimental procedure



Signal acquisition, preprocessing and HEP extraction

EEG (28 electrodes, modified 10-10 international system) and ECG were acquired using g.tec's g.Nautilus headset (sampling frequency: 500 Hz). Low-pass (45 Hz) and high-pass (0.5 Hz) FIR filtering was followed by interpolation of bad channels and rejection of artifact components provided by independent component analysis. Cleaned data were epoched [-200 ms, 600 ms] according to the R-peaks in the ECG and baseline corrected by subtracting the mean amplitude of the time window preceeding the R-peak from the rest of the epoch.

Variables

HEP amplitudes (μV) for all 28 EEG electrodes.
IA index calculated for every heartbeat counting trial as
1 - (|recorded heartbeats - counted heartbeats| / recorded heartbeats)
Self-reported attention paid to the heartbeats (range: 0 - 10).

Statistical analysis

Cluster-corrected ANOVAs were performed for every time point of HEP from 200 ms to 600 ms in every channel (univariate in Part 1 and mixed with 3 groups x 4 conditions design in Part 2). Amplitudes in the time windows of significant group differences were averaged and correlated with SHSS: A scores. Differences in the IA index were assessed by mixed ANOVA (3 groups x 3 trials), followed by ANCOVA controlling for attention paid to the task and correlation analysis of IA and SHSS: A scores.

Results

Part 1

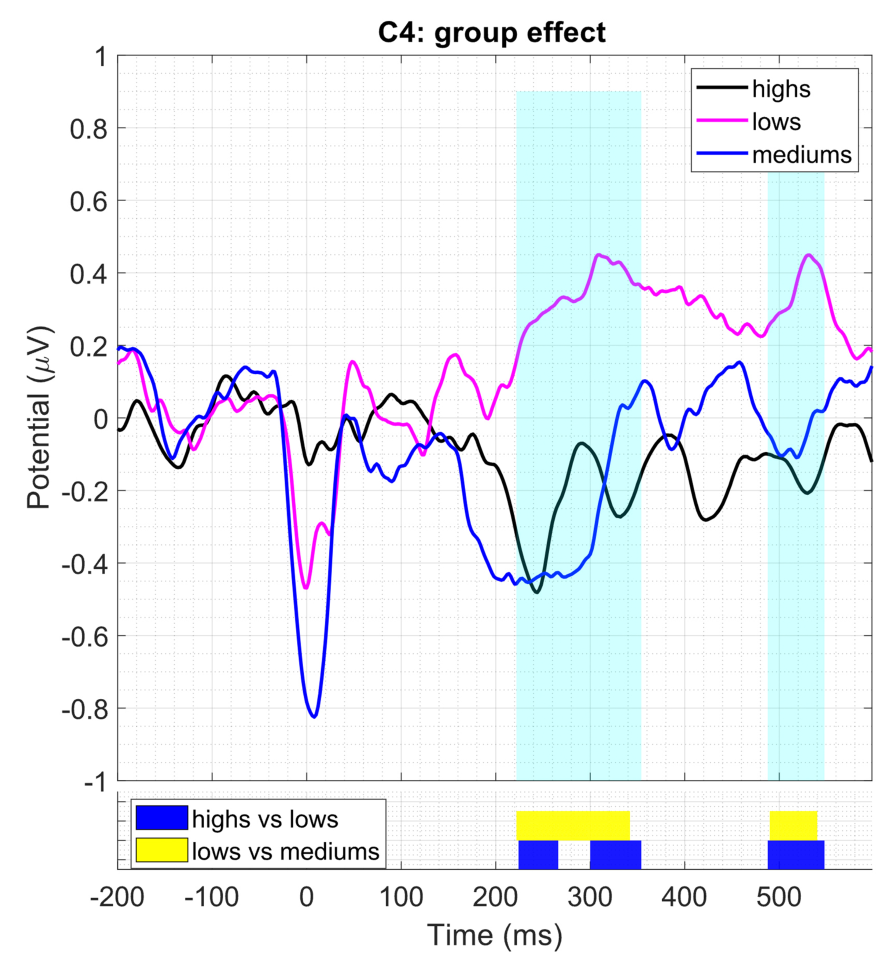
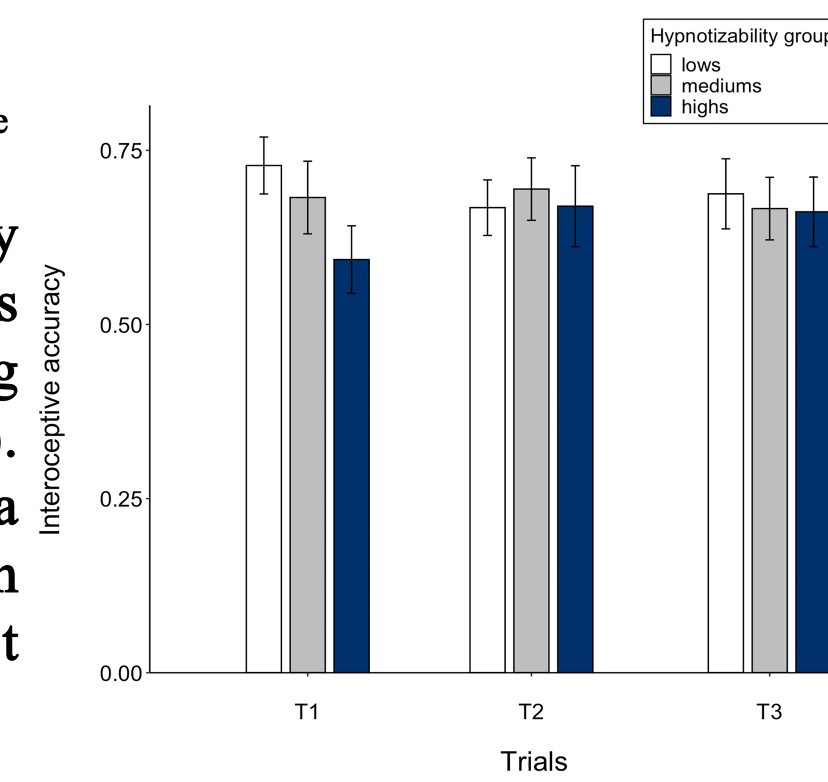


Fig. 1. Hypnotizability group differences in HEP (C4) during 10-minute open-eye rest (cyan bars indicate time windows of significant group differences, while yellow and blue bars indicate significant post-hoc intervals).

HEP amplitudes differed between hypnotizability groups in right central region C4 in the early (224 - 354 ms, p = .009) and late (490 - 548 ms, p = .028) HEP components. The amplitudes of lows were significantly higher compared to the amplitudes of mediums and highs.

Part 2

Fig. 2. Cardiac interoceptive accuracy in three heartbeat counting trials.



IA did not differ significantly between hypnotizability groups and trials (even when controlling for self-reported attention). Correlation analysis revealed a negative association between SHSS:A scores and IA in the first counting trial (r = -.31, p = .035).

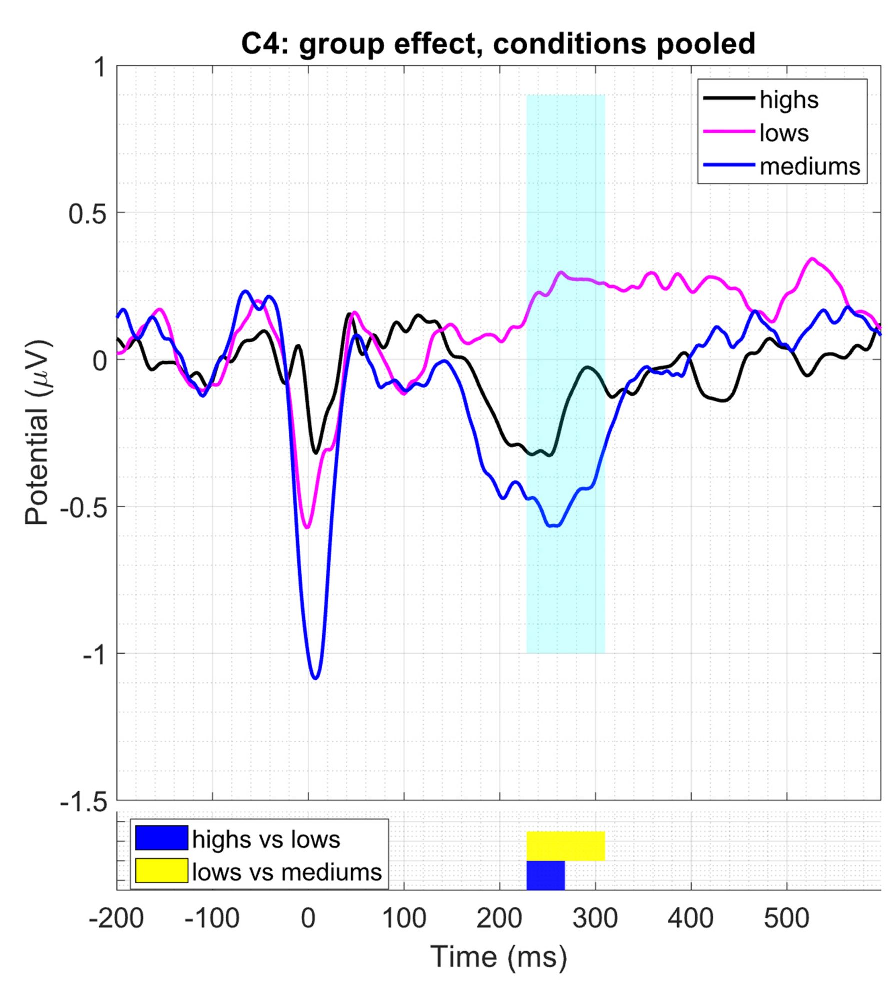


Fig. 3. Hypnotizability group difference in HEP (C4) during Part 2 (cyan bar indicates a time window of significant group difference, while yellow and blue bars indicate significant post-hoc intervals).

In Part 2, the main effect of hypnotizability group was observed in C4 in the early HEP component (230 - 310 ms, p = .035), with the amplitudes of lows being significantly higher compared to mediums and highs. The mean amplitude of this time interval also negatively correlated with SHSS: A scores (r = −.40, p = .006).

In the frontal sites, a significant group x condition interaction was observed in the late HEP component (FC1: 508–538 ms, Fz: 494–546 ms, F3: 510–544 ms), with only mediums showing higher amplitudes during HBC compared to OE/CE conditions and only highs showing higher amplitudes during POST compared to HBC.

Conclusions

The baseline interoceptive processing of the general population (mediums) seems to be more similar to that of highs than to that of lows. Moreover, the effect of attention paid to the heartbeats on interoceptive processing may only be present in mediums (HBC > OE/CE), whereas interoceptive learning may be more efficient in highs (POST > HBC).

Since interoception is altered during spaceflight (*Teaford et al., 2022*), which can affect emotion regulation and decision-making (*Kever et al., 2015; North & O'Carroll, 2001*), our findings suggest a potential role of hypnotizability assessment in astronaut selection and their postflight treatment. Ongoing research further investigates the efficacy of interoceptive imagery training as a function of hypnotizability, which is also characterized by differences in functional equivalence between imagery and perception (*Ibáñez-Marcelo et al., 2019*).

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